

# Physics Department Overview

HEP Annual BNL Program Review

4/22-23/04

S. Aronson

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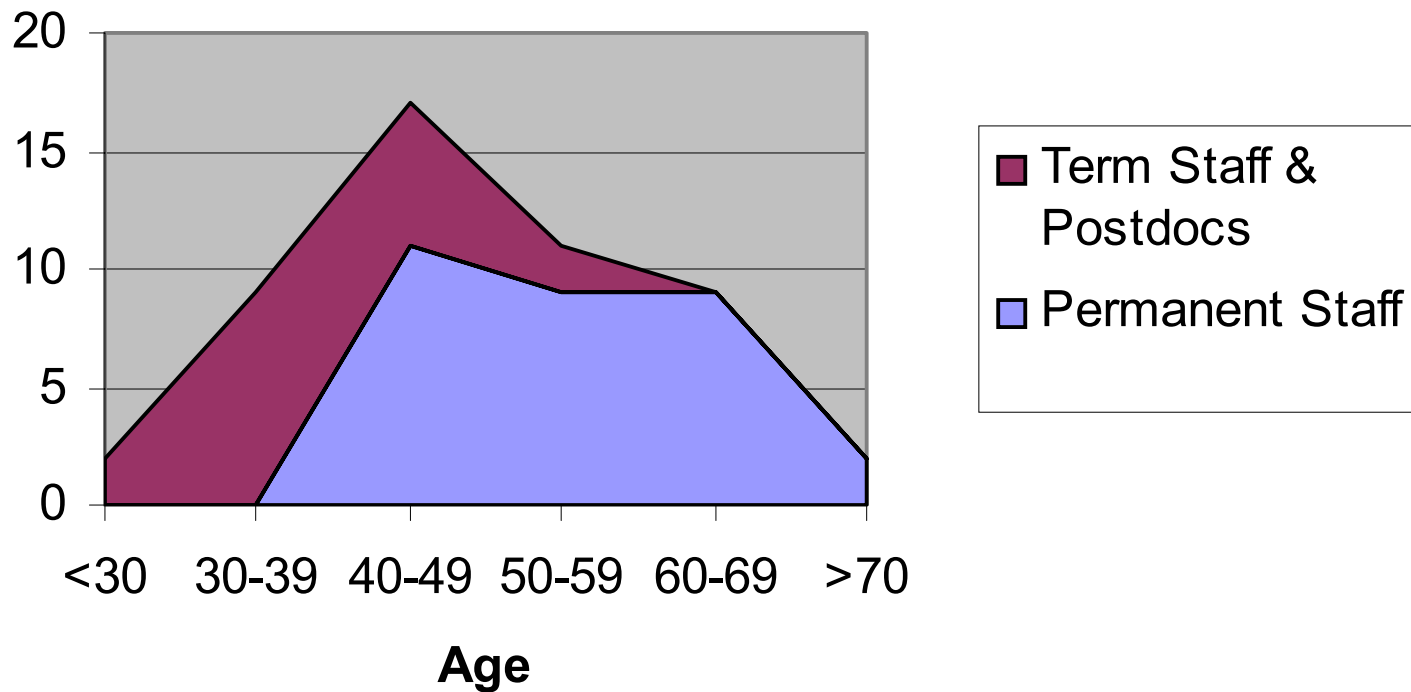
- ◆ Mission & demographics
- ◆ Research thrusts
- ◆ Funding history
- ◆ Current and near-term budgets
- ◆ Issues
- ◆ Outlook

# Mission & demographics

- ◆ The Physics Department's HEP mission is to perform and support forefront research in particle physics
  - Long tradition of AGS, CERN and Fermilab research
- ◆ The hosts BNL's scientific program in HEP with the following staff:

|                   |             |
|-------------------|-------------|
| Scientists        | 44.3        |
| Prof. (incl. IT)  | 28.7        |
| <u>Tech/Admin</u> | <u>19.6</u> |
| TOTAL             | 92.6 FTEs   |
- ◆ The total HEP new B/A in FY 2004 (KA11, KA14, KA15) is \$19,417,000 (as of March 04)

## Age Distribution of HEP PhDs



- ◆ Tight funding → dearth of post-docs and junior level staff members

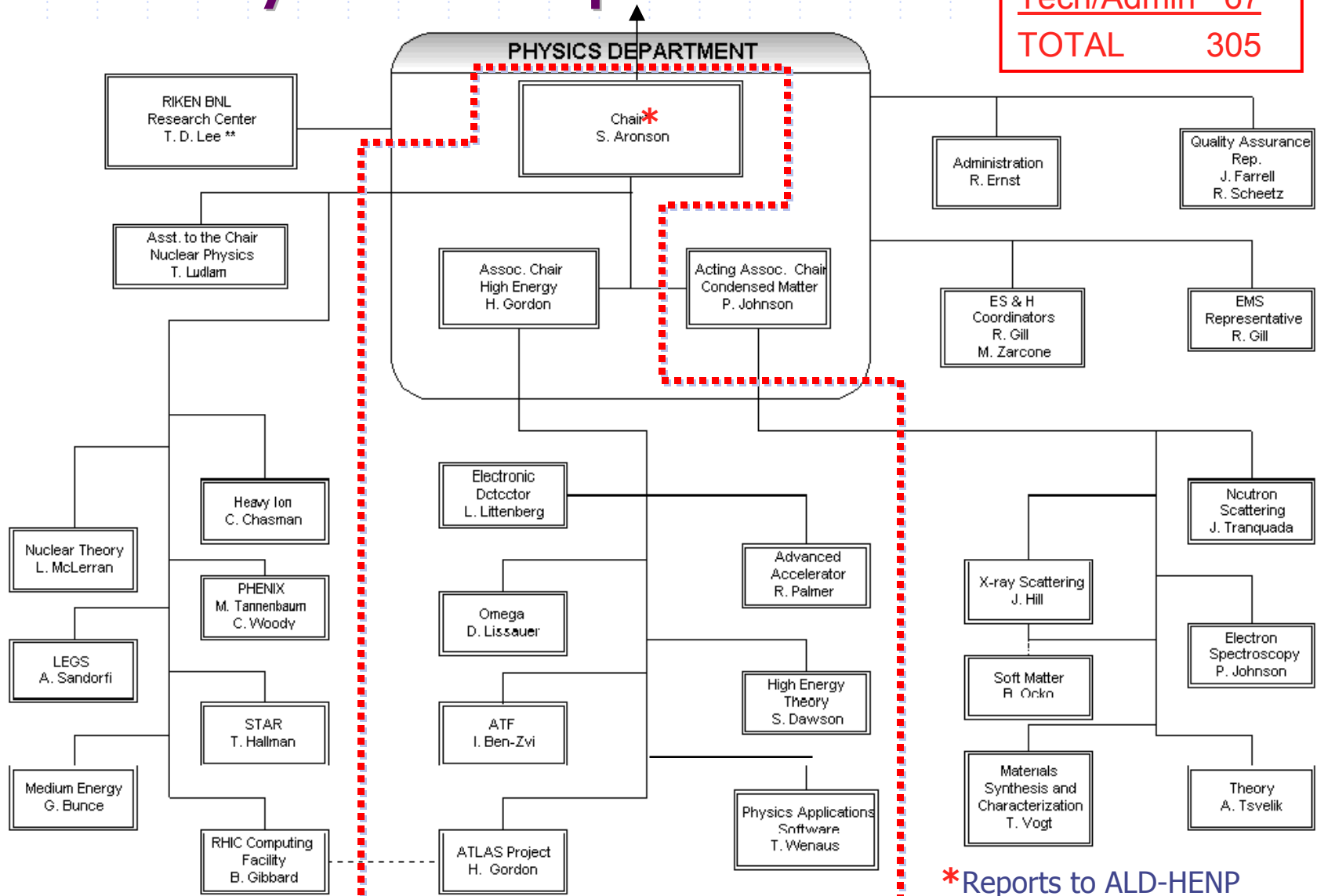
# Average labor costs

## ◆ Five and ten-year trends

| Category            | Grade       | Average Salary    |        |               | Avg Salary + Fringe & Indirects<br>2004 |
|---------------------|-------------|-------------------|--------|---------------|---|
|                     |             | 1994              | 1999   | 2004          |   |
| Tenured Scientist   | S-4         | 75,842            | 92,487 | 103,015       | 221,483                                 |
| Scientist           | S-3         | 72,908            | 81,564 | 96,223        | 206,879                                 |
| Research Associates | RA-1        | 39,033            | 40,313 | 48,145        | 95,809                                  |
| Technicians         | T-7 to TW-1 | 46,605            | 56,983 | 65,841        | 141,558                                 |
|                     |             | 5 YEAR INCREASE % |        | 10 INCREASE % |   |
| Tenured Scientist   | S-4         |                   | 22%    | 36%           |   |
| Scientist           | S-3         |                   | 12%    | 32%           |   |
| Research Associates | RA-1        |                   | 3%     | 23%           |   |
| Technicians         | T-7 to TW-1 |                   | 22%    | 41%           |   |

# BNL Physics Department

|                   |            |
|-------------------|------------|
| Scientists        | 163        |
| Prof./ IT         | 75         |
| <u>Tech/Admin</u> | <u>67</u>  |
| <b>TOTAL</b>      | <b>305</b> |



# Current and Planned Research Thrusts

## ◆ ATLAS

*H. Gordon, D. Lissauer, S. Rajagopalan, M. Harrison*

- SUSY, Higgs, energy frontier
- Construction → M&O
  - ◆ Physics Analysis Center and Research Mission
  - ◆ LHC Accelerator & Magnet R&D

## ◆ RSVP

*D. Bryman, W. Molzon*

- Rare processes  $\Leftrightarrow$  BSM sensitivity      LHC
  - ◆  $K^0 \rightarrow \pi^0 \bar{\nu} \nu$ ,  $\mu^- N \rightarrow e^- N$
- FY2005 NSF construction

## ◆ D0

### ■ Run II

- ◆ 300pb<sup>-1</sup> on tape
- ◆ Analyses focusing on BSM (SUSY, Higgs) and Heavy flavors (B<sub>s</sub> mixing, K<sub>s</sub>)

*A. Patwa*

## ◆ Neutrino oscillations

### ■ MINOS

- ◆ Data taking under way – physics soon!

*W. Marciano, T. Roser*

### ■ Very Long Baseline Oscillations

- ◆ AGS power upgrade + large underground detector
  - Proton decay



## ◆ HEP Theory

*S. Dawson, M. Creutz, F. Paige*

- Strongly coupled to the experimental program
  - ◆ ATLAS, Linear Collider, RSVP, neutrinos
- Lattice gauge theory
  - ◆ Will benefit greatly from new QCDOC computers

## ◆ Cosmology

*S. Aronson*

- New research effort
- Centered initially on LSST project
  - ◆ Dark Energy equation of state via weak lensing

## ◆ Accelerator R&D in the Physics Dept.

### ■ Accelerator Test Facility

*I. Ben-Zvi*

#### ◆ Proposal-driven User Facility

- High-brightness photoinjector electron gun
- 70 MeV linac
- High power lasers synchronized to the electron beam to the picosecond level

### ■ Advanced Accelerator R&D

*R. Palmer*

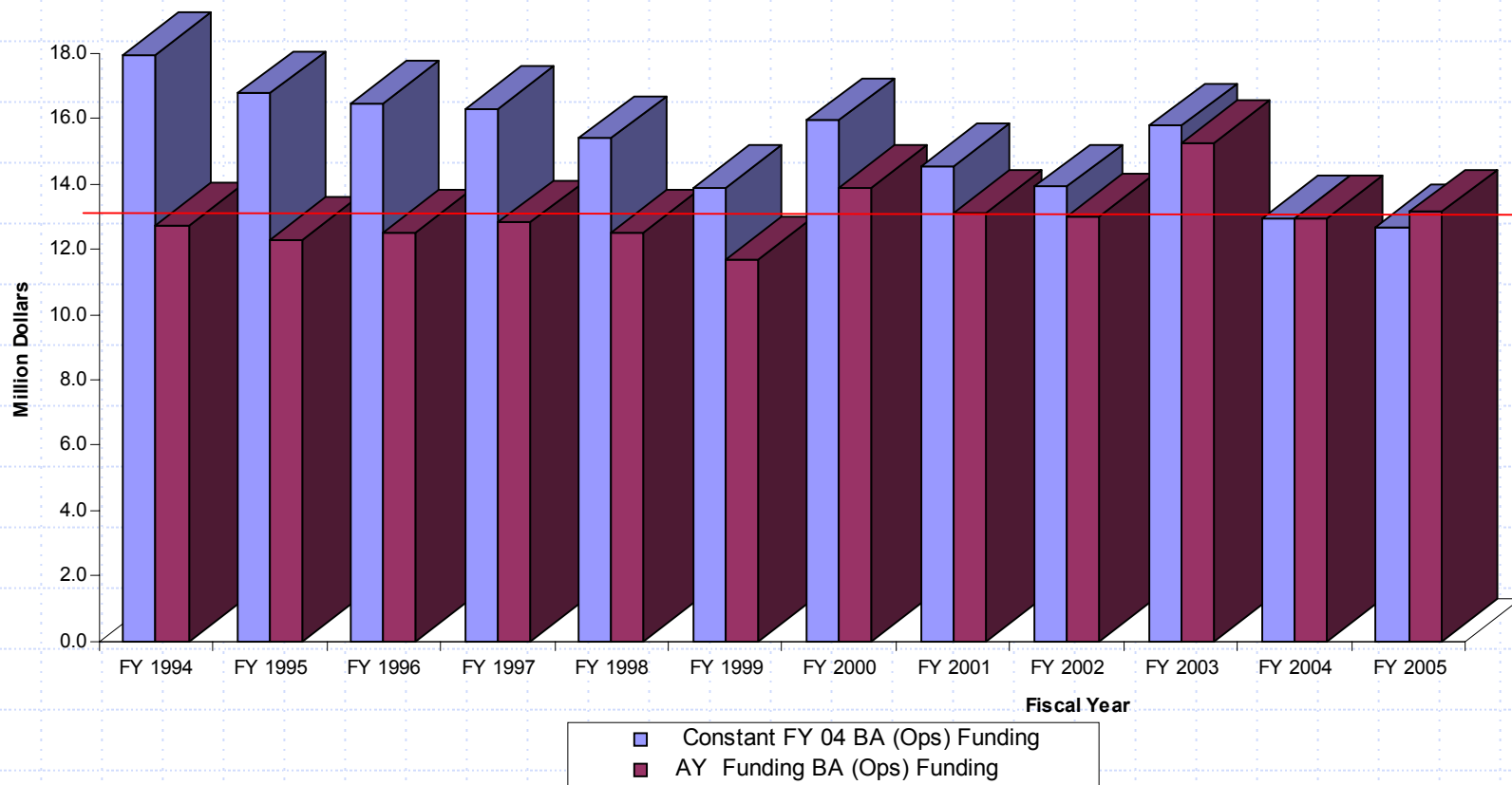
#### ◆ Muon Collider/Neutrino Factory

- Targeting, FFAG cooling ring studies

# Funding History:

Operating funds in AY & 04 \$M: Research, Theory/SciDAC, R&D

Brookhaven National Laboratory Physics Dept DOE HEP BA Operations Funding shown in  
AY Actuals and Constant FY 04 Purchasing Value  
Millions Dollars



# Budget Overviews: 03→04→05

## Physics Department HEP Budgets at BNL

|                                   | FY 03<br>Actual<br>(\$M) | FY 04 <sup>1</sup><br>Actual<br>(\$M) | FY 05 P <sup>2</sup><br>P. Bud<br>(\$M) |
|-----------------------------------|--------------------------|---------------------------------------|---|
| KA 11 01, 02 (Research)           |                          |                                       |   |
| Phys Research                     | 8.68                     | 7.00                                  | 6.84                                    |
| ATLAS R&D/Constr Ops              | 5.72                     | 0.61                                  | 0.44                                    |
| ATLAS Software & Compt            | 1.60                     | 1.13                                  | 1.27                                    |
| ATLAS Experimental Support        | 0.40                     | 1.01                                  | 0.00 <sup>3</sup>                       |
| ATLAS Cap. Eqp.                   | 6.79                     | 2.40                                  | 1.03                                    |
| Non- ATLAS Eqp.                   |                          | 0.99                                  | 1.00                                    |
| KA 14 01, 01,03 (Theory / SciDAC) | 2.68                     | 2.27                                  | 2.43                                    |
| KA 15 01,02, 03 (Accel. R&D)      |                          |                                       |   |
| ATF & CAP                         | 1.93                     | 1.98                                  | 2.05                                    |
| Muon Accelerators                 | 1.05                     | 0.96                                  | 0.96                                    |
| Detector Dev                      | 0.93                     | 0.87                                  | 0.87                                    |
| Eqp                               | 0.50                     | 0.20                                  | 0.19                                    |
| Physics Dept HE Ops Total         | 23.00                    | 15.83                                 | 14.85                                   |
| Physics Dept HE Eqp Total         | 7.29                     | 3.59                                  | 2.22                                    |

<sup>1</sup> March 2004 DOE Fin. Plan

<sup>2</sup> FY 2005 President's Budget

<sup>3</sup> Per FY 2005 President's Budget, but expect funds TBD later

# Budget Overviews: 05 scenarios

## Physics Department HEP Budgets at BNL Fiscal Year 2005 Budget Scenarios

|                                   | FY 05P P.<br>Bud<br>(\$M) | FY 05 PY<br>@ +2%<br>(\$M) | FY 05 PY<br>@ -2%<br>(\$M) |
|-----------------------------------|---------------------------|----------------------------|----------------------------|
| KA 11 01, 02 (Research)           |                           |                            |                            |
| Phys Research                     | 6.84                      | 6.98                       | 6.70                       |
| ATLAS R&D/Constr Ops              | 0.44                      | 0.45                       | 0.43                       |
| ATLAS Software & Compt            | 1.27                      | 1.29                       | 1.24                       |
| ATLAS Experimental Support        | 0.00                      | 0.00                       | 0.00                       |
| ATLAS Cap. Eqp.                   | 1.03                      | 1.05                       | 1.00                       |
| Non- ATLAS Eqp.                   | 1.00                      | 1.02                       | 0.98                       |
| KA 14 01, 01,03 (Theory / SciDAC) | 2.43                      | 2.48                       | 2.38                       |
| KA 15 01,02, 03 (Accel. R&D)      |                           |                            |                            |
| ATF & CAP                         | 2.05                      | 2.09                       | 2.01                       |
| Muon Accelerators                 | 0.96                      | 0.98                       | 0.94                       |
| Detector Dev                      | 0.87                      | 0.89                       | 0.85                       |
| Eqp                               | 0.19                      | 0.19                       | 0.19                       |
| Physics Dept HE Ops Total         | 14.85                     | 15.15                      | 14.56                      |
| Physics Dept HE Eqp Total         | 2.22                      | 2.26                       | 2.17                       |

# Budget Overviews: 06 scenarios

## Physics Department HEP Budgets at BNL Fiscal Year 2006 Budget Scenarios

|                                   | FY 05 P.<br>Bud<br>(\$M) | FY 06 BY<br>@ -10%<br>(\$M) | FY 06 BY<br>Flat Flat<br>(\$M) | FY 06 BY<br>@ +2%<br>(\$M) |
|-----------------------------------|--------------------------|-----------------------------|--------------------------------|----------------------------|
| KA 11 01, 02 (Research)           |                          |                             |                                |                            |
| Phys Research                     | 6.84                     | 6.16                        | 6.84                           | 6.98                       |
| ATLAS R&D/Constr Ops              | 0.44                     | 0.39                        | 0.44                           | 0.45                       |
| ATLAS Software & Compt            | 1.27                     | 1.14                        | 1.27                           | 1.29                       |
| ATLAS Experimental Support        | 0.00                     | 0.00                        | 0.00                           | 0.00                       |
| ATLAS Cap. Eqp.                   | 1.03                     | 0.92                        | 1.03                           | 1.05                       |
| Non- ATLAS Eqp.                   | 1.00                     | 0.90                        | 1.00                           | 1.02                       |
| KA 14 01, 01,03 (Theory / SciDAC) | 2.43                     | 2.18                        | 2.43                           | 2.48                       |
| KA 15 01,02, 03 (Accel. R&D)      |                          |                             |                                |                            |
| ATF & CAP                         | 2.05                     | 1.85                        | 2.05                           | 2.09                       |
| Muon Accelerators                 | 0.96                     | 0.87                        | 0.96                           | 0.98                       |
| Detector Dev                      | 0.87                     | 0.78                        | 0.87                           | 0.89                       |
| Eqp                               | 0.19                     | 0.17                        | 0.19                           | 0.19                       |
| Physics Dept HE Ops Total         | 14.85                    | 13.37                       | 14.85                          | 15.15                      |
| Physics Dept HE Eqp Total         | 2.22                     | 1.99                        | 2.22                           | 2.26                       |

# FY03 Year End Supplemental funds

- ◆ FY03 supplemental funding received support 03/04 Activities
  - **\$330k** → QCDOC
  - \$130k → ***Post Doc Support***

# FY04 Funding compared to FY03

- ◆ Experimental Research decreased by net 6% (with Equipment offset)
  - Accounting for 3.5% escalation of labor (which dominates the budget) → a reduction of 2 FTEs. Ongoing, with attrition and termination of non-permanent staff
- ◆ FY04 supplemental funding received
  - **\$300k** → Physics Analysis Center
- ◆ ATLAS, D0, RSVP, Theory, MINOS, E949 analysis continue
  - All understaffed, need post-docs and/or junior staff
  - D0, MINOS may be sub-critical
  - Negative impact on physics results from E949
  - Not possible to staff any possible g-2 running
- ◆ Performance goals, issues
  - Would not affect the % completion of ATLAS
  - Difficult to add needed FTEs to ATLAS (e.g., Physics Analysis Ctr.)



# FY05 Budget Scenarios

- ◆ FY05P compared to FY04 → reduction of ~7 FTE
- ◆ FY05 at -2% reduction from President's Request
  - -2% (plus 3.5% Labor escalation) in Research →
    - ◆ reduction by additional 1 to 2 FTE
    - ◆ ATLAS, RSVP, Theory, MINOS, DO – all stressed and inefficient
- ◆ FY05 at +2% increase from President's Request
  - Partially offsets growth in the cost of Labor; reduction ~8FTE
    - ◆ Highest priority is ATLAS
- ◆ What would we be doing with growth above this level?
  - Add additional staff to the ATLAS Physics Analysis Center
  - Add staff to the Very Long Baseline Neutrino concept
  - Start funding of staff for Cosmology Group and LSST
  - Add theory staff for Lattice Gauge Theory work on QCDOC

# FY06 Budget Scenarios

- ◆ FY06 funding at  $-10\%$  of FY05 President's Request: A further reduction of  $\sim 10$  FTEs in experimental HEP
  - ATLAS, RSVP, MINOS, D0 all under stress; D0 definitely sub-critical
  - Give up 1 physics and 1 service topic from D0+MINOS; No E949
- ◆ FY06 funding flat-flat @ FY05: further reduction of 2-3 FTE
  - ATLAS, RSVP, MINOS, D0 in better shape; No E949
- ◆ FY06 funding at 2% increase of FY04: A further reduction of 1 FTE
  - ATLAS, D0, RSVP, E949 possible
- ◆ What would we be doing with growth above this level?
  - Continuing to staff up ATLAS Physics Analysis Center, Very Long Baseline Neutrino effort
  - Establishing viable Cosmology/LSST research effort
  - Adding to Theory effort, especially in Lattice Gauge computation

# Issue

- ◆ The trend in base program funding
  - We are and will be terminating programs that have not been scientifically exploited to their full potential
  - Some scientifically important programs (e.g., EDM) do not seem to fit in any scenario
  - Surviving programs are or will be understaffed
    - ◆ Theory group cannot keep a reasonable number of post-docs
  - Accelerator physics groups
    - ◆ ATF is holding close to constant effort
    - ◆ AAR&D is not; it will become sub-critical

# Outlook

## ◆ Where do we want to be in 5 years?

- Main research thrusts should be
  - ◆ Built up or building up efforts in ATLAS, RSVP, Theory, neutrinos, LSST and accelerator R&D
  - ◆ Winding down or completed efforts D0, g-2, E949

## ◆ What would that take?

- Next slide shows manpower plan and funding relative to flat-flat that would support such a position

# Staffing/funding plans for where we want to be

|  | FY04  | FY05  | FY06   | FY07   | FY08   | FY09               |
|--|-------|-------|--------|--------|--------|--------------------|
| <b>Physicists (FTEs)</b>               |       |       |        |        |        |                    |
| ATLAS (Base Rsrch Prog/Upgrd R&D)      | 6.4   | 6.4   | 6.4    | 7      | 8      | 8                  |
| ATLAS Physics Analysis Center          | 5     | 7     | 9      | 11     | 15     | 15                 |
| D0                                     | 5.1   | 4     | 4      | 3      | 2      | 1                  |
| K Decays (E949-> KOPIO)                | 6.7   | 7     | 7      | 7      | 7      | 7                  |
| Muon (g-2->MECO)                       | 2.8   | 2.8   | 3.8    | 3.8    | 3.8    | 3.8                |
| Neutrino (MINOS + VLB)                 | 1     | 1     | 2      | 3      | 3      | 3                  |
| LSST                                   | 0     | 1.5   | 1.5    | 4      | 5      | 6                  |
| <b>Admin (FTEs)</b>                    | 2.1   | 2     | 2      | 2      | 2      | 2                  |
| <b>Technicians (FTEs)</b>              | 4.6   | 4.7   | 0.1    | 0      | 0      | 0                  |
| <b>Professional (FTEs)</b>             | 5     | 3.9   | 3.9    | 3      | 3      | 2                  |
| <b>Total FTEs (FTEs)</b>               | 38.7  | 40.2  | 39.6   | 43.8   | 48.8   | 47.8               |
| <b>Post Docs(Heads) included above</b> | 3     | 5     | 7      | 6      | 7      | 8                  |
| <b>Funding Needed (FY04 M\$)</b>       | 9.203 | 9.572 | 9.429  | 10.417 | 11.607 | 11.369             |
| <b>Escalation</b>                      | 1.000 | 1.035 | 1.071  | 1.109  | 1.148  | 1.188              |
| <b>Funding Needed (AYM\$)</b>          | 9.203 | 9.907 | 10.100 | 11.549 | 13.320 | 13.503             |
| <b>DOE Guidance (AYM\$)</b>            | 7.870 | 7.710 | 7.710  | 7.710  | 7.710  | 7.710 <sup>1</sup> |
| <b>Carryover</b>                       | 1.112 | 0.000 | 0.000  | 0.000  | 0.000  | 0.000              |
| <b>Total Available Funding</b>         | 8.982 | 7.710 | 7.710  | 7.710  | 7.710  | 7.710              |
| <b>Shortage (M\$)</b>                  | 0.221 | 2.197 | 2.390  | 3.839  | 5.610  | 5.793              |

## Notes:

\* Also assumes constant support for KA150302 Detector R&D 0.870M in FY04

<sup>1</sup> No DOE Guidance for FY06 or beyond - assume flat-flat from FY05

Still incomplete program: NO support for EDM, LC R&D, etc.

# Outlook

## ◆ Where do we want to be in 5 years?

- Main research thrusts should be
  - ◆ Built up or building up efforts in ATLAS, RSVP, Theory, neutrinos, LSST and accelerator R&D
  - ◆ Winding down or completed efforts D0, g-2, E949

## ◆ What would that take?

- Previous slide shows manpower plan and funding relative to flat-flat that would support such a position
- To preserve ATLAS at the indicated FY09 strength, ***all*** other work would have to stop

# Staffing/funding plans for HE Theory

| BNL Physics Department HEP Theory                            |  |         |       |       |       |       |                    |
|--|--|---------|-------|-------|-------|-------|--------------------|
|  |  | Current |       |       |       |       |                    |
|  |  | FY04    | FY05  | FY06  | FY07  | FY08  | FY09               |
| Physicists (FTEs)  |  |         |       |       |       |       |                    |
| Theory   |  | 9.6     | 11.0  | 11.0  | 11.0  | 11.0  | 11.0               |
| Admin (FTEs)   |  | 1.0     | 1.0   | 1.0   | 1.0   | 1.0   | 1.0                |
| Technicians (FTEs)   |  |         |       |       |       |       |                    |
| Professional (FTEs)  |  |         |       |       |       |       |                    |
| Total FTEs (FTEs)  |  | 10.6    | 12.0  | 12.0  | 12.0  | 12.0  | 12.0               |
| Post Docs(Heads) included above                              |  | 2       | 3     | 4     | 4     | 4     | 4                  |
| Funding Needed (FY04 M\$)                                    |  | 2.423   | 2.644 | 2.644 | 2.644 | 2.644 | 2.644              |
| Escalation   |  | 1.000   | 1.035 | 1.071 | 1.109 | 1.148 | 1.188              |
| Funding Needed (AYM\$)                                       |  | 2.423   | 2.736 | 2.832 | 2.931 | 3.034 | 3.140              |
| DOE Guidance (AYM\$)   |  | 2.268   | 2.268 | 2.268 | 2.268 | 2.268 | 2.268 <sup>1</sup> |
| Carryover  |  | 0.000   | 0.000 | 0.000 | 0.000 | 0.000 | 0.000              |
| Expected Funding   |  | 0.000   | 0.000 | 0.000 | 0.000 | 0.000 | 0.000              |
| Total Available Funding                                      |  | 2.268   | 2.268 | 2.268 | 2.268 | 2.268 | 2.268              |
| Shortage (M\$)   |  | 0.155   | 0.468 | 0.564 | 0.663 | 0.766 | 0.872              |
| 1 No DOE Guidance for FY06 or beyond - assume flat from FY05 |  |         |       |       |       |       |                    |

# Staffing/funding plans for ATF

BNL Physics Department HEP ATF & Accelerator Programs under KA15

|                                 | Current<br>FY04 | Minimum program + High Priority New Initiative |       |       |       |                    |
|---------------------------------|-----------------|--|-------|-------|-------|--------------------|
|                                 |                 | FY05   | FY06  | FY07  | FY08  | FY09               |
| Physicists (FTEs)               |                 |  |       |       |       |                    |
| ATF                             | 1.7             | 3.2  | 3.2   | 3.2   | 3.2   | 3.2                |
| Accelerator                     | 2.5             | 2.4  | 2.4   | 2.4   | 2.4   | 2.4 <sup>2</sup>   |
| Admin (FTEs)                    | 0.7             | 0.7  | 0.7   | 0.7   | 0.7   | 0.7                |
| Technicians (FTEs)              | 2.8             | 2.5  | 2.5   | 2.5   | 2.5   | 2.5                |
| Professional (FTEs)             | 6.2             | 5.1  | 5.1   | 5.1   | 5.1   | 5.1                |
| Total FTEs (FTEs)               | 13.9            | 13.9   | 13.9  | 13.9  | 13.9  | 13.9               |
| Post Docs(Heads) included above | 1               | 2  | 2     | 2     | 2     | 2                  |
| Funding Needed (FY04 M\$)       | 3.061           | 3.061  | 3.061 | 3.061 | 3.061 | 3.061              |
| Escalation                      | 1.000           | 1.035  | 1.071 | 1.109 | 1.148 | 1.188              |
| Funding Needed (AYM\$)          | 3.061           | 3.168  | 3.279 | 3.394 | 3.512 | 3.635              |
| DOE Guidance (AYM\$)            | 2.939           | 3.014  | 3.014 | 3.014 | 3.014 | 3.014 <sup>1</sup> |
| Carryover                       | 0.034           | 0.000  | 0.000 | 0.000 | 0.000 | 0.000              |
| Expected Funding                | 0.085           | 0.000  | 0.000 | 0.000 | 0.000 | 0.000 <sup>3</sup> |
| Total Available Funding         | 3.058           | 3.014  | 3.014 | 3.014 | 3.014 | 3.014              |
| Shortage (M\$)                  | 0.003           | 0.154  | 0.265 | 0.380 | 0.498 | 0.621              |

<sup>1</sup> No DOE Guidance for FY06 or beyond - assume flat from FY05

<sup>2</sup> Also assumes continued funding under KC B&R of .5M in FY04

<sup>3</sup> Funding is in the initial April fin plan



# Summary

- ◆ BNL HEP has major ongoing and planned research efforts that are in excellent alignment with the OS Strategic Plan
- ◆ This program is *not supportable* at funding levels that are flat-flat relative to the President's FY05 budget
  - Elements of the program would have to be zeroed out before they pay a full scientific return on investment